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A Study on the Technique for Information Sharing and Presentation of Earthquake Disasters — By the Chuetsu Earthquake Restoration and Revival Support GIS Project —

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ABSTRACT

This study evaluates the information sharing method powerd by GIS technology following a Mw.6.8 earthquake on the middle area of Niigata (Chuetsu area) on 23rd October 2004. We established the Chuetsu Earthquake restoration and revival support GIS project. Many kinds of data about the damage situation that the government and local governments or associated organizations owned were unified by GIS technology, and it was shown as a portal site on the Internet. The data input process was done outside the damaged area. These data were offered to the damaged area, and only practical use was expected. The effectiveness was shown as one of the methods of restoration and revival support by activity of the project.

1. INTRODUCTION

A magnitude-6.8 earthquake struck at 17:56 on October 23, 2004 with intensity 7 recorded in Kawaguchi-machi. It left immense damage in the Chuetsu area, Niigata Prefecture. It was reported(1) that 46 people died and 2,824 houses were completely destroyed in the earthquake. The earthquake was accompanied by two large aftershocks of maximum intensity upper 6 within 30 minutes of the main quake. A total of 869 aftershocks were felt for two months after the main quake, and these long-term aftershocks significantly affected the lives of the victims, causing the number of evacuees to increase to 103,178 as of October 26, three days after the earthquake. In addition to this diversification of the evacuation situation, the damages frequently changed with aftershocks and rainfalls. The disaster headquarters of the local governments that had vigorous roles in dealing with the disaster had difficulty in collecting information, and the influence of this manifested itself in different forms such as restriction of the restoration support activities inside and outside the quake area and delay of the support for the victims. In Kawaguchi-machi, Kitauonuma-gun, the damage to the city hall building not only stopped the staff's support works in the building, but also terminated the electricity due to the absence of a private power generator. So the office staff had to work for the support activities with little or no outward transmission of information. Under this situation, some tried to conduct acquisition and provision of information outside the quake area in an integrated fashion by using GIS (Geographical Information System), tracking the damages in real time and transmitting the damage information, in order to support the activities inside and outside the damaged area. This was the "Chuetsu Earthquake Restoration and Revival Support GIS Project," conducted with nation-wide government-industry-academia cooperation. In this article, based on the previous report[1] as well as on the result of a survey regarding the project activity, we summarize the project and subsequent activities and future perspectives and issues, and discuss methods for support activities in damaged areas with information communication technologies and GIS.

2. OVERVIEW OF THE PROJECT

2.1 Process to the establishment

The disaster headquarters set up in the local governments in the damaged areas started collecting damage information immediately after the earthquake. However, in the initial stage, the acquired information was often given in hard copy and not digitalized. Certainly no one could produce GIS data quickly to collect information in the current situation. In particular, when an area with a small local government suffers disaster, as in this earthquake, the limited human resources available have to be concentrated on emergency activity, which may allow direct support work but not indirect work such as the collection of wide-area information, including damages in neighboring communities, that is needed to receive external support. In other words, almost no concrete activities were conducted to respond to these needs.

The project was planned to allow sharing of disaster information from the Chuetsu Earthquake by using GIS, based on this local government's situation and the experience in the restoration and revival process for the Hanshin-Awaji Earthquake on January 17, 1995. Use of GIS had just started in the Hanshin-Awaji Earthquake although the sharing and utilization of GIS data were

KEY WORDS: GIS, Chuetsu Earthquake, Restration and Revival Support, GIS Portal Site, Information Sharing

not fully performed. The project planning was also promoted by the increasing possibility of data creation and sharing in the recent technological development of information communication and processing, and by the fact[2), 3)] that GIS helped integrate data owned by various related organizations in the rescue operations after the simultaneous multiple terrorist attacks in New York City, USA on September 11, 2001, and it contributed considerably to appropriate, rapid actions. On November 3, almost two weeks after the earthquake, major disaster-prevention organizations, GIS providers, private companies, and academic organizations including universities responded to the request and gathered at a meeting in Tokyo to create a formal agreement for the project. In establishing the project, various information was collected from the organizations that participated in the project, including the Ministry of Land, Infrastructure and Transport. Also in the preparatory phase of the project, establishment of the WebGIS system for releasing data, web site designing, and server construction were conducted. After the preparatory phase, the web site[(2)] of the "Chuetsu Earthquake Restoration and Revival Support GIS Project" was opened to the public to provide data on November 15, three weeks after the earthquake (**Table 1**). In the WebGIS, the "Chuetsu Earthquake Information Collection Map"[(4)], for example, was frequently used, which was produced based on "Cyber Japan"[(3)] that had been developed by the Ministry. The project explored the possibilities of use of the WebGIS in a variety of situations by creating the system so as to integrate more and more information in cooperation with such web sites.

Table 1. Project schedule

Date	Event
10/23	Chuetsu Earthquake
11/3	First meeting
11/12	Servers installed
11/15	Formal opening of the project web sites
11/22	Temporary termination of the sites
11/24	Second meeting
12/16	Servers replaced
12/17	Service started on new servers
12/22	Third meeting
1/17	Renewal of the sites
1/19	Metadata reference service started
2/15	Link made to Disaster GIS volunteer network

2.2 Web site organization

For the release of the project's web site, the top page was put in a WWW server owned by Nagaoka Institute of Design, the local head office. Web sites for other contents such as an information provision site using WebGIS, a download site for A0-sized entire area information maps, a download site for A3-sized pieces of the entire area information map, and a site for description of the project's objectives are all stored in a server owned by Kokusai Kogyo Co., Ltd. that was responsible for management. The domain of the top page is that of the Nagaoka Institute of Design (chuetsu-gis.nagaoka-id.ac.jp) and the domain of the other sites is one newly acquired (chuetsu-gis.jp).

Before the release, two servers with the same functionality were set up in Tokyo and Nagano to reduce load on the WebGIS, except for the top page, and on the PDF download sites, in order to construct an environment such that stable operation was available. However, as heavy maintenance was expected to be necessary for the WebGIS at the start of the site operation, the plan was changed to create a distributed system to provide the WebGIS service from the server in Tokyo and the PDF download service from the server in Nagano. The installation work of the servers was completed on November 12 in Nagano and the web sites were opened to the public on November 15.

In the early stage of the release, the top page contained as a portal site links to content-providing sites such as the PDF download service site and the WebGIS site, as well as to the web sites of typical disaster areas and the site for the description of the project's objectives. The map data provided in the PDF download site was designed to present a clear layout of as much information as possible. In the PDF download site, A0-sized data was available and a capability for providing A3-sized cut pieces of the map was ensured to make the map data printable under various conditions. Also, printed A0 maps were sent to staff in the damaged areas to promote their use for the local restoration activities. The WebGIS site had the capability of changing various characteristic base maps such as IKONOS satellite images, topographic maps on a 1/25000 scale issued by the Geographical Survey Institute, SPOT satellite images, etc (**Table 2**). Also the information subject to the base maps could be selected with accessibility to other information such as field survey results and photographs of the damaged areas.

2.3 Characteristics of the project

The characteristics of the project are listed below:

1. Integrated collection of information from various organizations to GIS with background images such as IKONOS satellite

Table 2. Base maps used

Viewable background data	Scale	Production date
Numerical map 25000 map images	1/25,000	Oct. 1, 1997 – Dec. 1, 1998
IKONOS satellite images	Approx. 1/2,500 with 1m resolution	Taken on Oct. 29, 2004 and Nov. 23, 2004
SPOT satellite images	2.5m resolution	Taken on Nov. 9, 2004
PAREA GeoNet	1/25,000	2003
Aster satellite DEM (Gradient tint image with shadow)	15m resolution	Taken on Nov. 10, 2004
Snow images around Imogawa River	1m resolution	Dec. 2004 and Feb. 2005

images and topographic maps on a 1/25000 scale issued by the Geographical Survey Institute

2. Information on road closure, evacuation centers, and volunteer centers is updated daily (until the end of December)
3. Provision of comprehensive responses to the disaster and entire image of the disaster necessary for support activities by volunteers and various organizations outside the damaged areas
4. High precision satellite images to help us check the current status of the restoration and revival works (e.g. the state of landslide)
5. Provision of printable map data and direct mailing of printed maps to help people in the disaster areas recognize the situation easily

In addition to the topographic maps on a 1/25000 scale issued by the Geographical Survey Institute, high precision satellite maps (IKONOS images) were provided as base maps on the release of the sites. The satellite maps with 1m resolution were extremely useful to figure out the damage and topographical conditions. Also the data of the Chuetsu Earthquake Information Collection Map released by the Ministry was provided at the start of the project. As a result the objectives of the project were widely known in various fields immediately after the opening of the web sites, which helped information provision from different organizations (**Table 3**).

The disaster headquarters of the damaged areas were in an extremely disordered condition. Various information provided through the emergency support activities and the restoration and revival processes was not all prepared as digital data, and almost no information was given in GIS data with location data. One of the aims of the project at its early stage was that information should be collected outside damaged areas and its outcome should be returned to the areas to support quicker responses to the disaster. The project staff received not only data from the supporting organizations, but also information on the Internet provided by every local government, and conducted data input works. The information on the damage in each city, town, or village, provided by Niigata Prefecture, was given on the web site as one of the links to various information from the city, town or village. The information that could be used to locate the evacuation centers was provided as point data (**Fig. 2**). The data on the project web site was in principle updated daily from the formal release date until the end of December. The conditions of the damaged areas changed daily due to, for example, aftershocks, and the survey results and collected data from the supporting organizations were gradually accumulated for provision to the project. Also information provided by the governments changed from time to time. Therefore the real time response to the changing conditions, which was extremely important from the viewpoint of the project's aim, was realized just because a large amount of human resources was concentrated outside the damaged areas. This might create a huge burden on the management organization of the web sites.

The information collection in the project is characteristic in that the management of the project itself is backed by the voluntary activities of the supporting organization, which realizes wide-area information provision across the local governments, and that the integrated acquisition of information from not only the central government, but also the volunteers in the damaged areas helps us know various aspects of what is going on in the damaged areas.

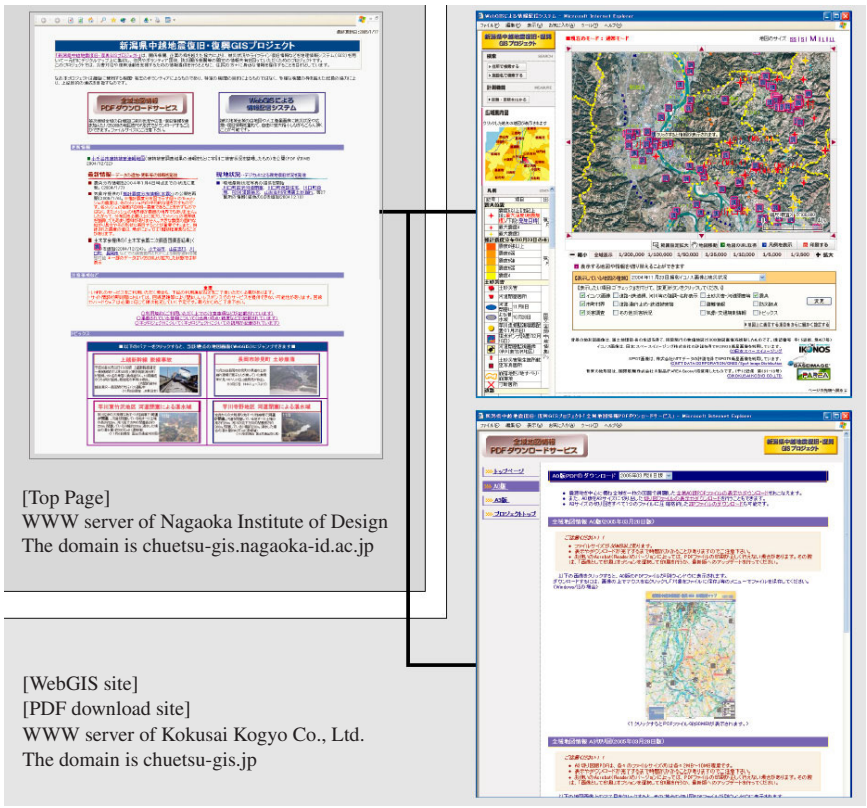

Fig. 1 Web site organization

Since damages do not occur independently in each local community, it is essential to provide an entire image of the damages particularly in wide-area disasters. The organization form and actual activities of the project therefore gave a suggestion on future collection and provision of disaster information. Since the start of the web sites, the entire-area information was provided as PDF data that could be used for integrated understanding and for use as a paper map by downloading and printing it. This capability is considered important in particular for information sharing in the damaged areas. Most of the activities in the damaged areas were field works, and hence they were not always conducted in an environment with Internet facilities. Also the supporting organizations expressed that printed paper maps would be more useful for the information sharing in the field activities with many people being involved. In consideration of these issues, it was decided not only to provide downloadable data, but also to send printed maps directly to the damaged areas, because people in the damaged areas might be able to download the data but not have facilities such as a plotter to print out A0-sized maps. Even when they could obtain the facilities, they did not have enough time for such tasks. We consider that the project could not only make contributions through typical operation and support for required labor, but also create a

Table 3. Viewable layers and contents in WebGIS

Viewable layer	Information contained		Date of production, information collection, or revision	Reference
Cities, towns, and villages	Lifeline restoration information	Electricity	Dec. 28, 2004	Niigata Prefecture
		Gas	Dec. 28, 2004	
		Water	Dec. 28, 2004	
		Telephone	Dec. 27, 2004	
		Cell phone	Dec. 27, 2004	
Sediment disaster, blocked river, etc	Major sediment disaster points		Nov. 4, 2004	Chuetsu Earthquake Information Collection Map, Ministry of Land, Infrastructure and Transport
	Blocked rivers		Nov. 16, 2004	
	Flooded areas around blocked rivers		As of Oct. 28, 2004 and Nov. 8, 2004	
	Air photos of landslide disaster points		Oct. 24, 2004	
	Monitoring and restoration information (Blocked river monitoring images, installation of monitoring devices along Imogawa River and sump pumps)		Dec. 15, 2004 (Installation of monitoring devices along Imogawa River) Dec. 24, 2004 (Installation of sump pumps)	
	Landslide and collapse site maps		Late December, 2004	
Road closure, railway damage, etc	Road closure to general vehicles		As of Mar. 25, 2005	Chuetsu Earthquake Information Collection Map, Ministry of Land, Infrastructure and Transport
	Damaged river-control facilities		As of Feb. 3, 2005	
	Train situation		Mar. 25, 2005	Niigata branch, East JR Company
	JR railway damages		Nov. 19, 2004	East JR Company
Seismic center	Seismic center distribution		- Mar. 21, 2005	Japan Meteorological Agency
Estimated intensity distribution	Estimated intensity distribution		Major earthquake on Oct. 23, 2004	Chuetsu Earthquake Information Collection Map, Ministry of Land, Infrastructure and Transport
Other damages	Disaster situation (Damaged sewage lines, damaged parks, photos of damaged areas, etc)		Oct. 23, 2004 (Damaged parks, etc.) Dec. 3, 2004 (Damaged sewage lines)	Chuetsu Earthquake Information Collection Map, Ministry of Land, Infrastructure and Transport
	Concrete survey on public sewage lines, damaged sewage lines near rivers (Manholes)		As of Nov. 5, 2004	
	Damage on city hall buildings		Nov. 12, 2004	Fire and Disaster Management Agency
	Cross shot of damaged areas		Oct. 24, 2004	Asahi Airlines Co., Ltd., Asia Air Survey Co., Ltd., Kokusai Kogyo Co., Ltd., and PASCO
	Local information blogs and local reports		As needed from Dec. 10, 2004	Rescuenow Inc.
Evacuation information	Evacuation situation		Dec. 21, 2004 All the evacuation centers were closed	Local governments and Niigata Prefecture
	Provisional housing		Dec. 22, 2004	
Disaster prevention center	Situation of disaster support volunteer center		Dec. 17, 2004	Fire and Disaster Management Agency (Information related to disaster volunteers and donations)
	Fire headquarters		-	Fire and Disaster Management Agency
	Police department		-	Niigata Prefectural Police
	Disaster headquarters		-	Local governments, etc
	Office of the Ministry of Land, Infrastructure and Transport		-	Hokuriku Regional Development Bureau, Ministry of Land, Infrastructure and Transport
Weather and traffic regulation information (*)	Weather information		Released from Jan. 31, 2005	"Snow information in Niigata Prefecture" from General Policy Division, Niigata Prefecture, and Japan Meteorological Agency
	Traffic regulation information		Released from Jan. 31, 2005	"Traffic regulation information" from Civil Engineering Division, Niigata Prefecture, and "Live Camera from your Niigata hometown" from Niigata Prefecture
	Real-time weather information		As required since Nov. 11, 2004	AMEDAS, Japan Meteorological Agency
	Real-time rainfall and water level information		As required since Nov. 11, 2004	"Real-time disaster-prevention information for rivers," Ministry of Land, Infrastructure and Transport
Disaster survey	Results from the secondary survey group of the Japan Society of Civil Engineerings		Obtained and released on Dec. 24, 2004	Japan Society of Civil Engineering

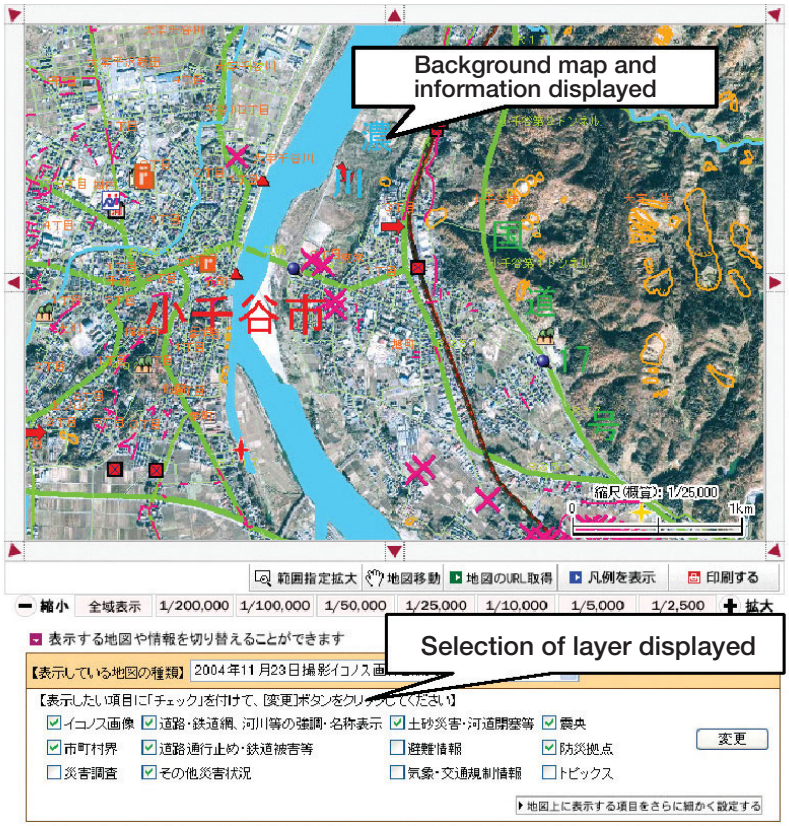

Fig. 2 Information provided on the WebGIS site.

situation where people in the damaged area only just needed to use the provided support. We would also like to point out that a set of these works could be successful only with the devoted and continuous social contribution activities of the project supporting organizations located outside the damaged areas.

3. DEVELOPMENT AFTER THE WEB SITE RELEASE

The project's web site formally released on November 15 attracted huge attention from inside and outside the damaged area. It appeared in newspapers and Internet portal sites, and that day, i.e. on November 22, the web site consequently recorded 3,300 accesses and 390,000 hits. The overwhelming accesses caused system down of the server in Nagaoka Institute of Design. The project started after the earthquake with related information provided by various organizations and related technologies that had been developed by them. Priority was placed on early launch of the project by preparing the system tentatively. As a consequence, we found some problems in the provided data and the system to develop the subsequent activities.

Since December 2004 when the messy situation of the launched project was converging, the system was improved sequentially to improve availability of the web site. Although the server's functional capabilities were shared between the servers in Tokyo and Nagano in the initial stage of the web site, the system configuration was changed to have the Nagano server cover the WebGIS and PDF download services by enhancing its performance and the Tokyo server backup the Nagano server. This new server system started on December 17. Subject data, including damaged area information and survey research results, were collected from the supporting organizations since the earthquake to improve the data resources. The survey result was provided as point data to the project on December 24 by the secondary survey group of the Japan Society of Civil Engineering and was opened to the public. In order to distribute damaged area information on the development of the restoration works, the situation of the support activities, etc, the area information that Rescuenow.net had been collecting was also reflected as subject data of the WebGIS service after December 10. From December 16, a new function that allows us to select any data previously released, in addition to the latest updated data, was added to the PDF data download service of A0 and A3 maps, so that we could see temporal change of the state-sarea after the occurrence of the earthquake.

The supporting organizations supplied other new functions to enrich the services originally provided at the initial stage of the web site. The WebGIS service provided functions to utilize various information for users with Internet environments. To assist in further analysis, a service for providing metadata of topographical and spatial information started on January 19, 2005 by using the GIS application, etc[5]. When a similar disaster occurs in other areas in future, a quicker response than in this disaster would realize early support activities after the occurrence of the disaster. In consideration of this view, a framework of the "Disaster GIS volunteer network" was constructed for the purpose of data input based on the use of many supports from outside the damaged areas, and the link to the network was created on February 15[6]. In the network,

Fig. 3 Top page after the renewal

organizations and individuals, who agreed with the idea that support could be provided in a disaster by producing GIS data outside the damaged areas, were registered as GIS volunteers. A WebGIS-based input system was used in the network to construct data from information released on the Internet and from hand-written materials that the disaster headquarters created when a disaster occurs. Since the system was newly established after the Chuetsu Earthquake, it had no immediate effects on the restoration and revival works. However, a data input simulation was performed on the assumption that a disaster had occurred. For the simulation, the network groups borrowed and used the information materials created by the disaster headquarters in the damaged areas such as Ojiya City and Nagaoka City. The simulation result was used to analyze the precision and creation speed of data, how to classify text data produced in the disaster headquarters, and how to use data for the future[3].

The web site design was improved significantly on January 17, 2005 to respond to continuously arriving data and to make the interface easier to use (**Fig. 3**).

4. RESULT OF QUESTIONNAIRE

4.1 Summary of the questionnaire

The organizations to which the A0 wide-area maps were sent were surveyed to see their evaluation on the project and consider future orientation. The questionnaire was conducted in February and March and we received answers from 53 organizations. We summarize the result below.

4.2 On the entire-area map distributed

To the question of whether the entire-area maps helped, about 70% of the answers were "Helped" or "Somewhat helped." The other answers included the opinions that the maps were useless in areas other than the target areas. This is an important point and should be fully taken into account in providing entire-area maps in similar future projects. With regard to the method of use, about 40% of the maps were posted indoor for free view and there was no case where the maps were taken along and used outdoors, perhaps because of the A0 size of the distributed maps. As for the advantages of the entire-area maps, one of the project's aims "Various information was integrated in the maps" received the highest score, and also "The map size is large" and "New information is continuously updated" were highly esteemed (**Fig. 4**). However, the acknowledgement that new information is always updated is premised on continuous distribution of updated versions. So the result suggests the importance of distribution, at renewal time, of maps printed outside the damaged areas, and the high evaluation of the map size.

4.3 On the WebGIS site

35% of all the answers admitted the use of the project's WebGIS service. Among them, about 90% evaluated the service as "Helped" or "Somewhat helped," which indicates that the service was used effectively if used at all. To the question on information that was expected to be useful for this time and future similar activities (**Fig. 5**), there were many answers regarding traffic regulation and damage situation after the occurrence of a disaster. This tendency appeared probably because the survey targets were the organizations that participated in the operations responding to the disaster.

4.4 Other opinions

While there were opinions that the delivered maps were effectively used, some people outside the map area claimed that the name "entire-area" map should be changed or the areas should be extended to cover all the damaged areas. There was also an opin-

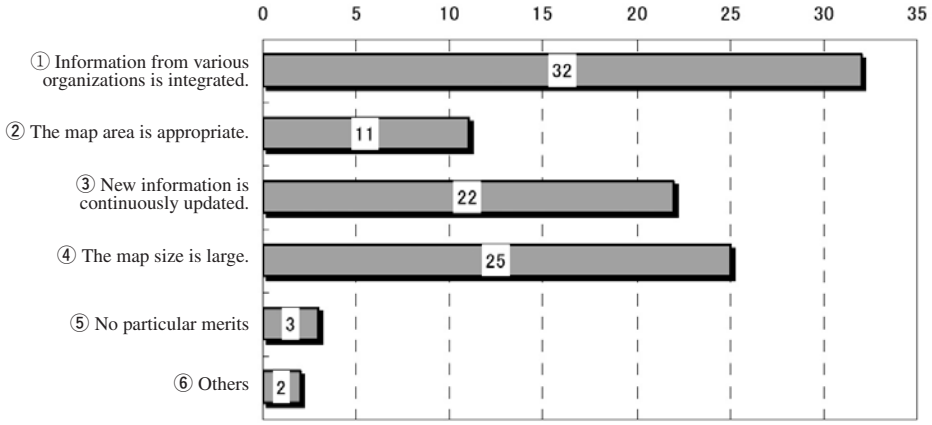

Fig. 4 Advantages of the entire-area map

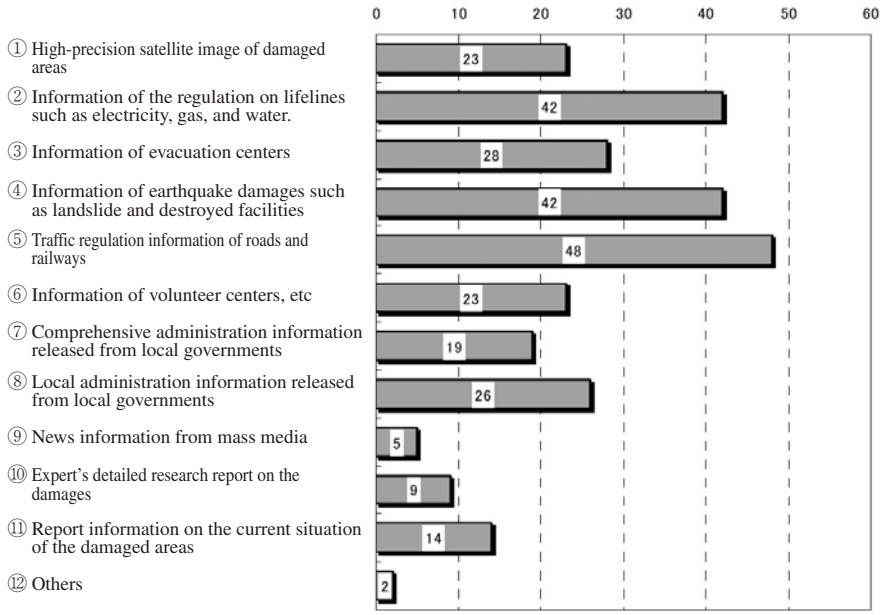

Fig. 5 Information considered useful

ion that the sufferers needed more detailed maps with recognizable features such that residential houses were recognizable and the 1/25,000-scale maps were useless for them. Some required quicker responses and some proposed that each organization should provide information more rapidly for public release.

5. SUMMARY

5.1 Significance of the project

The "Chuetsu Earthquake Restoration and Revival Support GIS Project" was based on the voluntary cooperation of the related and supporting organizations. The rapid and widely-obtained cooperation realized the distribution of their useful information and resulted in a certain significance. The significance of the project can be summarized as follows.

1. Major disaster-prevention organizations including the Ministry of Land, Infrastructure and Transport provided information responsively as required.
2. The survey companies and the GIS-related companies assisted the project in "ALL Japan."
3. The input of GIS data was conducted outside the damaged areas, and the "utilization of outcome," not "provision of human power," was required in the areas.
4. Unbiased portal site was opened at the university (academic organization) located in the damaged area and the web site worked as a true portal in collaboration with the supporting organizations.

Although it was acknowledged after the Hanshin-Awaji Earthquake that the information collection with GIS helped activities responding to a disaster, concrete development has not been

seen due to some issues such as the rights and form of data unification. Suffering actual disaster in the Chuetsu Earthquake, related organizations were motivated by social contribution to the damaged areas. With their support and the sufferer's request for early response, the concrete project was developed to determine the direction of GIS use and the method of data construction. The project was triggered by the information provision from major disaster-prevention organizations including the Ministry of Land, Infrastructure and Transport and by the supporting organizations that were engaged in the data visualization to concentrate the data in a more effective form of information. In the actual operation of the project, the effectiveness of the information sharing was recognized, which promoted the collection of various information such as local information and survey results of the academic society. Also a practical-level network was created among the supporting organizations in the process of these activities. The network is quite important for emergent works and its effective use could promote rapid responses to a disaster in future.

In the project, it was not precisely acknowledged what kind of information was needed in the damaged areas, and the project activities were conducted with the focus on what information could be collected in, and provided to, the damaged areas. As a result, the provided information might contain a type that was not necessary for the areas. However, we expect this issue will be solved by the repetition of similar activities. What was extremely important in the project was not the unnecessary information issue but the fact that the local staff engaged in actual response in the damaged areas were not required to collect and input information. The disaster-prevention GIS is premised, in many cases of actual disasters, on local operation in damaged areas. It is, however, almost impossible to create GIS data from a large amount of information obtained in the areas. Creating GIS data in the damaged areas could also disturb actual disaster-responding works such as rescue activities and commodity supply. It is considered to be one of the major significances that a damaged-area supporting framework was established to provide necessary information, in consideration of the facts that the GIS was used as an actual tool for information sharing and as information material for explanation, and that it was also used for understanding the local situations from outside the damaged areas and preventing unnecessary works in the damaged areas.

The last significance of the project is that the universities and academic organizations played a portal role and maintained their neutral position. We consider that this realized a wide range of the support from industry, government and academia. The universities were located in the damaged areas and hence could not fully participate in actual works such as data input, etc, although the creation of web sites at local universities and academic organizations could be important for the realization of smooth operation of projects when a similar situation arises in future. Also for future disaster, it is essential to keep the practical-level network mainly with neutral organizations.

5.2 Future problems and views

Although the project aimed at recovery and revival, it took 3 weeks to open the web site. Quicker response is therefore needed for emergency activities and future works are expected to realize this. In a series of the operations to rapidly acquire the information produced in the disaster headquarters, etc and accurately input it outside the damaged areas, the method of the arrangement and input of the information, the monitoring function for the precision of the information, and other points would be improved only if the supporting organizations of this project create stronger collaboration. In particular, many works were often required to convert the data that was provided by local governments andmany problems were found such as the conversion failure of the residential address data in intermediate and mountainous areas. However, in the disasters after the Chuetsu Earthquake, some activities were conducted based on the present project[7], and the repetition of similar activities will complete a more effective mechanism of the collection and provision of disaster information. In order to make activities in the next disaster more effective, it is an important future task to make a detailed analysis on useful information and take a close look at its use.

Acknowledgements

The authors would like to express their sincere thanks to various related organizations and individuals for their support in the promotion of the project.

Note

(1) Cabinet Office, "On the Niigata Chuetsu Earthquake 2004 (Vol. 54)"
(2) http://chuetsu-gis.nagaoka-id.ac.jp/
(3) http://cyberjapan.jp/index3.html
(4) http://zgate.gsi.go.jp/chuetsujishin/index.htm
(5) http://www.geographynetwork.ne.jp/disasters/explorer.jsp
(6) http://www.gis-volunteer.net/
(7) Similar activities were conducted in Fukuoka West-Offshore Earthquake that occurred on March 20, 2005, and a portal site was created at the Institute of Environmental Systems, Kyushu University.

REFERENCES

M. Sawada and H. Hayashi, "Chuetsu Earthquake Restoration and Revival Support GIS Project," Proceedings of the Institute of Social Safety Science, No. 16, pp.57-60, 2005 (in Japanese).

A. Kawasaki, et al., "Summary of survey research on the use of GIS in the WTC building crash disaster in New York City in 2001 -Development of GIS for risk management-," Proceedings of the Institute of Social Safety Science, No. 13, pp.109-110, 2003 (in Japanese).

A. Kawasaki and S. Sadohara, "Survey research 2 on the use of GIS in the WTC building crash disaster in New York City in 2001," Proceedings of Institute of Social Safety Science, No. 16, pp.1-4, 2005 (in Japanese).

T. Watanabe, "Remote creation of disaster GIS information by volunteer organizations," Proceedings of Institute of Social Safety Science, No. 16, pp.65-68, 2005 (in Japanese).